



People and Lakes

Human Influences on Africa's Lakes

Africa's lakes are among the most heavily exploited of all the continent's freshwater resources. With human populations continuing to grow, this pressure shows no sign of abating. While some countries may have high annual averages of available water per capita, many already face water stress—1 700 m³ (2 223 cubic yards) or less per person annually—or scarcity conditions—1 000 m³ (1 308 cubic yards) or less per person—(UNEP 1999). At present, 14 African countries are subject to water stress or scarcity, with those in Northern Africa facing the most pressure with 11 more countries expected to join them within the next 25 years (Hinrichsen 1997).

Freshwater fisheries are the main source of income and protein for millions of African people. The annual freshwater fish catch is estimated at about 1.4 million tonnes, with Egypt alone contributing about 14 per cent (UNEP 1999). However, the damming of the Nile, and the disposal of untreated sewage and industrial effluents, has endangered fish species and reduced the catch in many regions, including the Nile Delta and Lake Chad (Hinrichsen 1997). The introduction of exotic fish species into Africa's lakes has also reduced the number and size of indigenous fish populations – the most notable example being the impact of the Nile Perch (*Lates niloticus*) on the Tilapia (*Oreochromis* spp.) and other indigenous species in Lake Victoria.

The health of a lake is intrinsically linked to its watershed, and to changes made to the landscape. Over-extraction of water and diversions from rivers that feed lakes have been compounded by pollution and sedimentation. Many lakes also support extensive fisheries, with accompanying problems of stock depletion and invasive species. Meaningful long-term improvements in lakes can only result from a comprehensive look at their entire watersheds or basins.

Reservoirs serve many different and diverse functions. They improve water supplies for irrigation and for households, provide power, mitigate floods, and reduce dependence upon fossil fuels through the generation of hydroelectric power. The meeting of the combined needs of water and energy from dams and reservoirs must be balanced by the minimising and mitigating of their adverse environmental and social impacts.

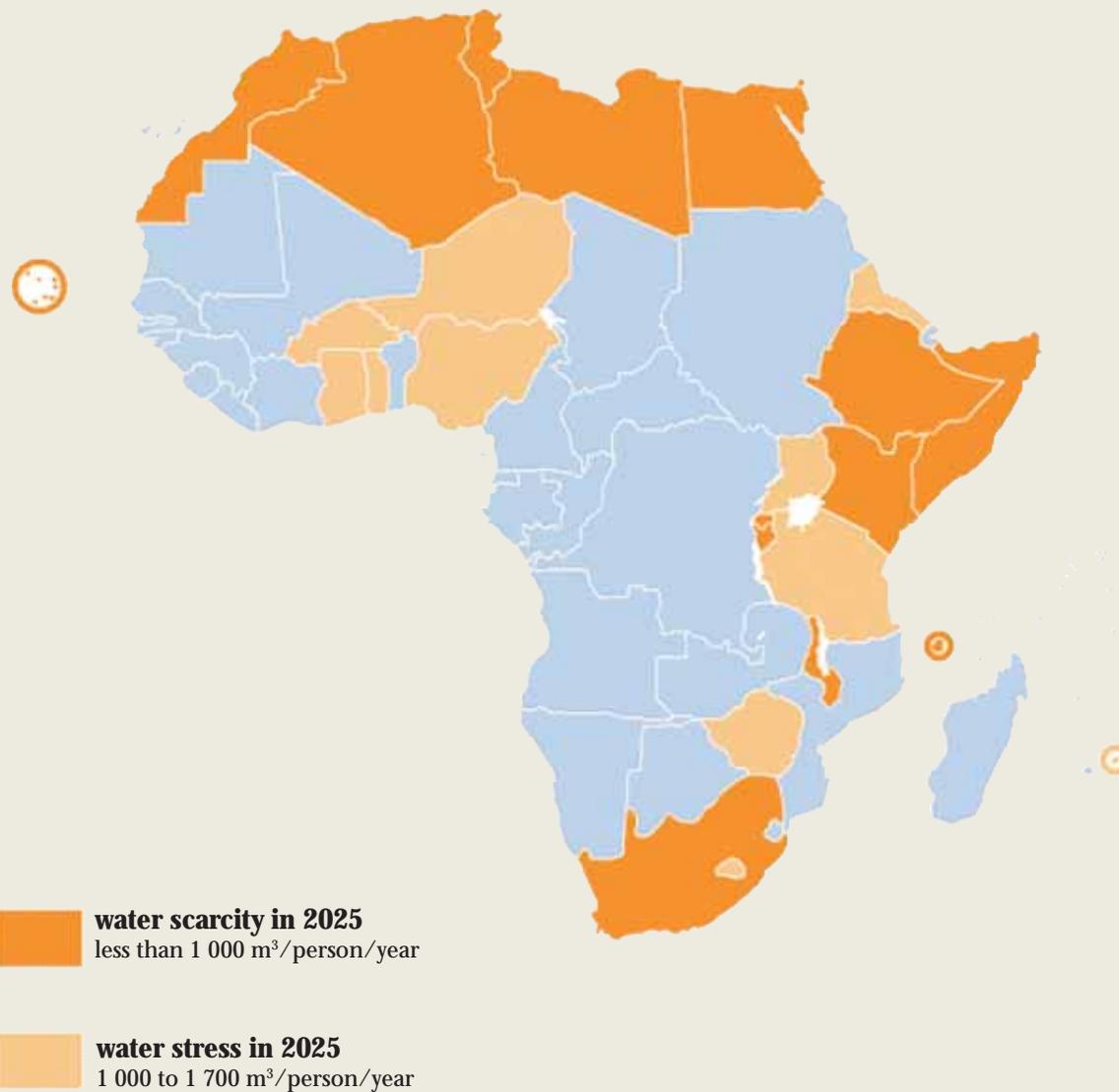


Figure 2.1: Predicted water stress and water scarcity in 2025

Source: UNEP 1999

Lakes also play a critical role in meeting the United Nations' Millennium Development Goals (MDGs) (IUCN 2004) as shown in Table 2.1 (see page 11).

Wetlands are defined as areas that are regularly saturated by surface water or groundwater, and are characterised by vegetation that is adapted for life in saturated soil conditions. They include swamps, bogs, fens, marshes and estuaries (USEPA 1994), and they generally support a rich biological diversity with many endemic and rare flora and fauna. Wetlands are found in most African countries. The largest include the Okavango Delta, the Sudd in the Upper Nile, Lake Victoria and Chad basins, and the floodplains and deltas of the Congo, Niger and Zambezi rivers. Despite being among the most biologically productive ecosystems on the continent, wetlands are often regarded, locally, either as wasteland, habitats for pests and a threat to public health, or as potential areas for agriculture. As a result, many wetlands are being lost

due to increasing pollution or conversion to agricultural use.

During the past two decades, Niger has lost more than 80 per cent of its freshwater wetlands (Niger Ministry of Environment and Hydraulics 1997). Coastal wetlands in Egypt and Tunisia and freshwater wetlands in the Sudan are also under increasing threat. Freshwater ecosystems found in lakes, rivers and wetlands may be the most endangered ecosystems of all. They have already lost a greater proportion of their species and habitats than terrestrial or marine ecosystems, and are in danger of further losses due to damming, pollution, over-fishing, and other threats (WRI, UNEP, UNDP and WB 1998).

Rising demands for increasingly scarce freshwater resources are leading to growing concerns about future access to these resources – particularly where they are shared between countries. Two or more countries share about 50 rivers in Africa. Access to water from any of these rivers



Flamingos—Kenya

Unknown/UNEP/Program for Global Environmental Teachings

could provoke conflict, particularly in the Nile, Niger, Volta and Zambezi basins (Hinrichsen 1997).

As in other dry regions, agriculture is the largest user of fresh water in Africa, accounting for an estimated 88 per cent of total water use (WRI, UNEP, UNDP and WB 1998). However, with only six per cent of cropland under irrigation, there remains considerable potential to increase food production through irrigation, and water demand for irrigation will inevitably continue to grow. Some 40-60 per cent of the region's irrigation water is currently lost through seepage and evaporation. This

contributes to serious environmental problems such as soil salinisation and waterlogging, although water 'lost' in this way may end up in aquifers where it can be pumped to irrigate nearby fields.

2.1 Population

Africa's population is expected to grow by 2.21 per cent from 2005-2010, and the growth rate is expected to decline by 1.8 per cent from 2020-2025. This compares to expected world population growth of 1.2 per cent from 2005-2010, and 0.8 per cent growth from 2020-2025. Increasing populations and corresponding water shortages

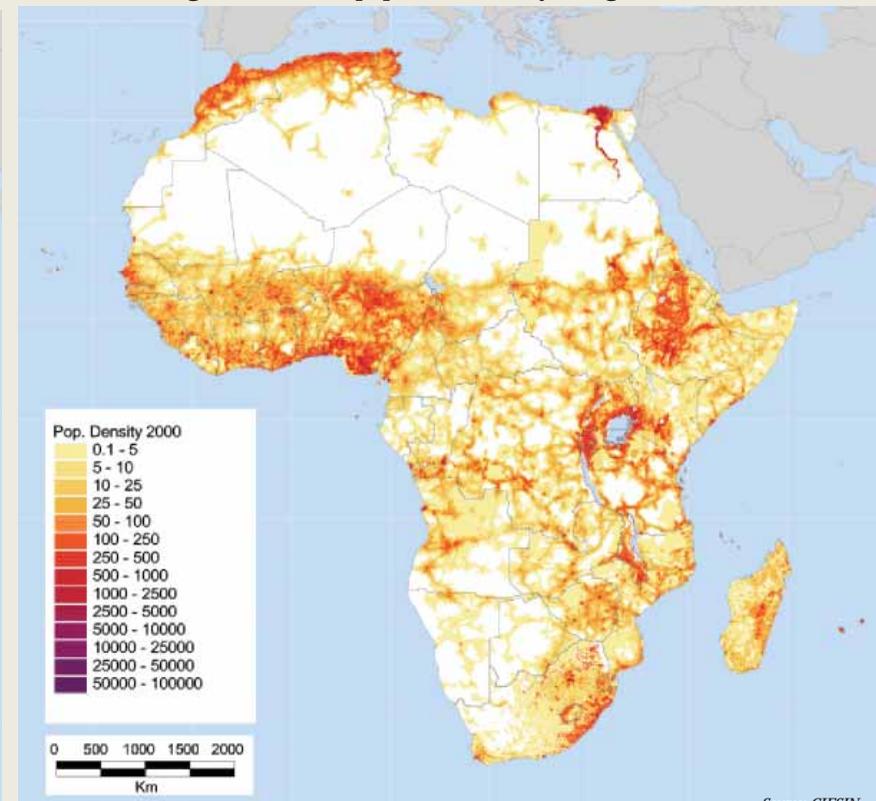
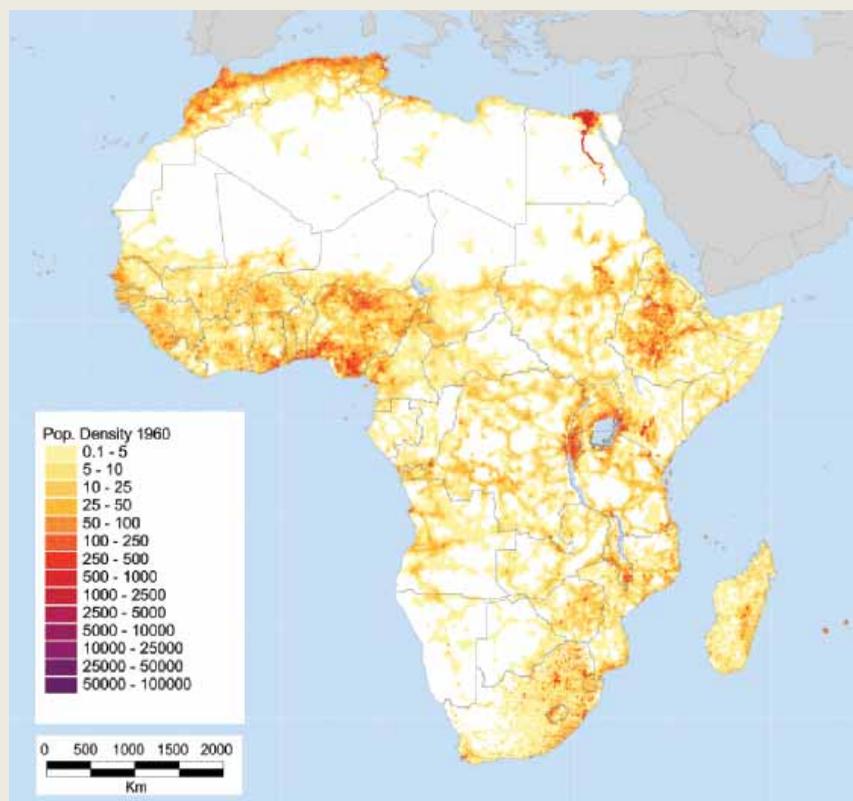
will exacerbate the challenges the continent faces in the third millennium, giving rise to an ever-greater need for regional cooperation in addressing water-related issues.

According to Harden (1968), Africa's growing population is the major cause of the degradation and pollution of most of the continent's lakes. Harden's theory appears to have stood the test of time, as high population increases continue to have negative impacts on most of Africa's lakes (Figure 2.2).

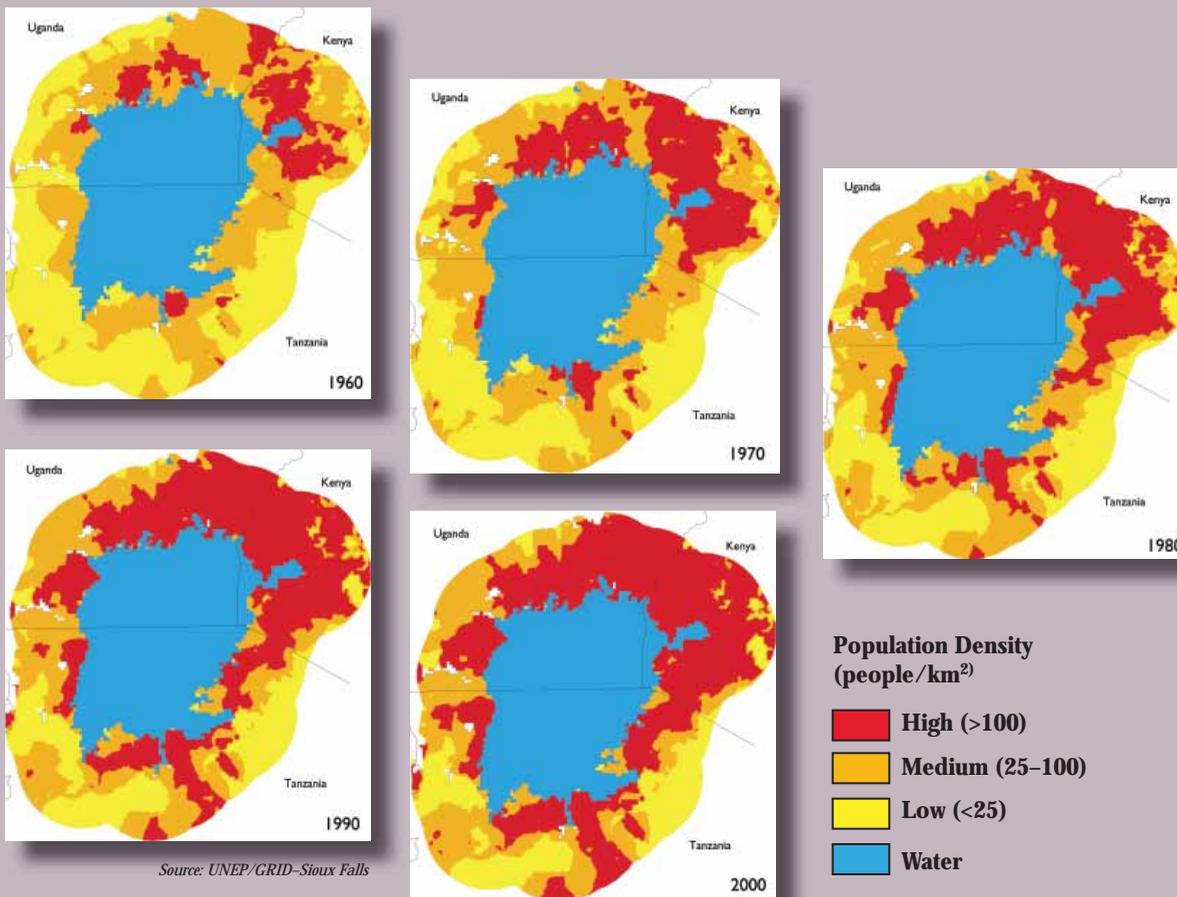
a)

b)

Figure 2.2: Africa population density changes. a) 1960s b) 2000s



Source: CIESIN



Ed Simpson/UNEP/PhotoSpin

Lake Victoria, Kenya

Population growth around Lake Victoria, Kenya, is significantly higher than in the rest of Africa because of the wealth of natural resources and economic benefits the lake region offers. Note the increase in population in a 100-km (62-mile) buffer zone around Lake Victoria between 1960 and 2000. During each decade, population growth within this zone outpaced the continental average.

2.2 Mainstreaming Culture and Tradition in the Management of Africa's Lakes

More than 3 000 ethnic groups, cultures and languages reside on the African continent. The tremendous beauty of its natural resources, its modern urban centres, its great mineral wealth, and its ancient cultures all establish that Africa has much to offer the world.

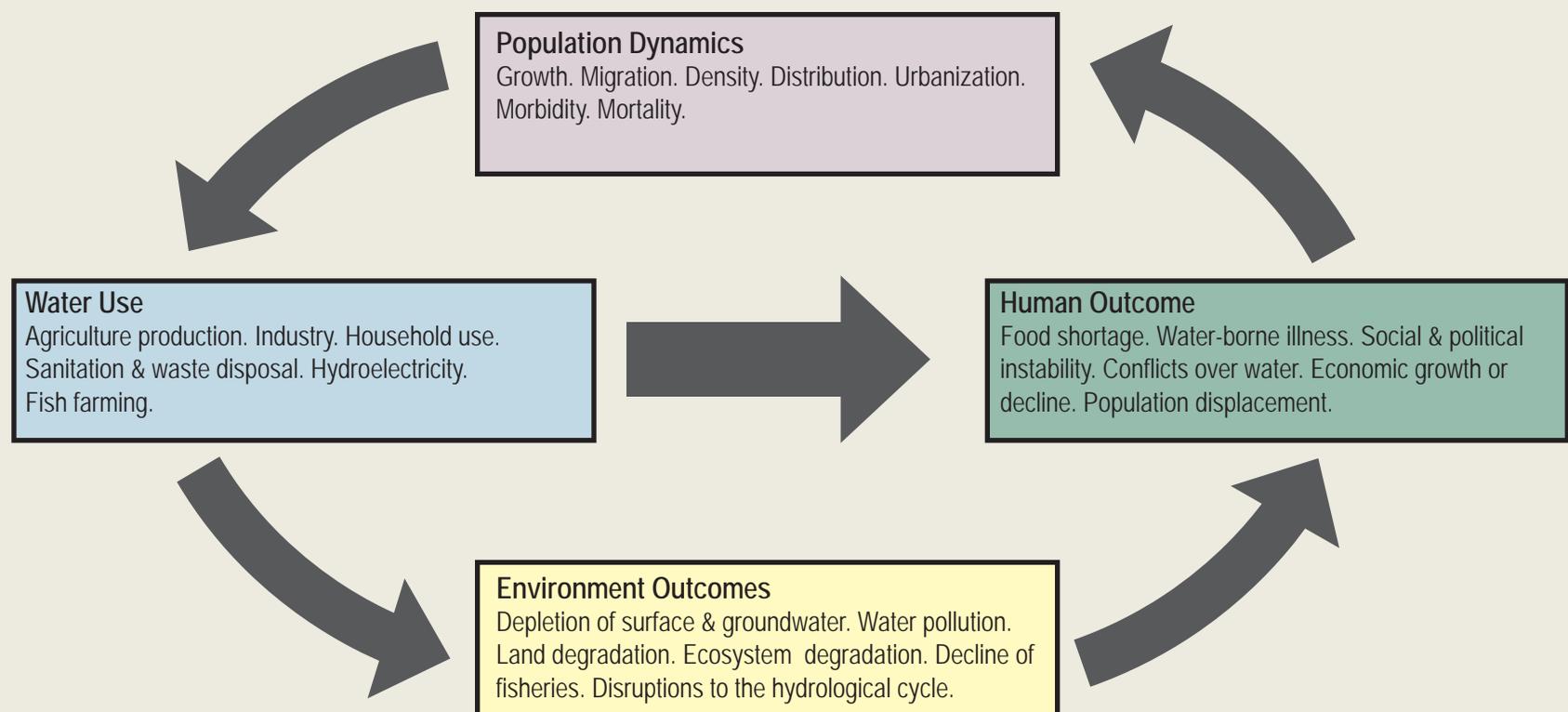
Although African cultures are not heterogeneous, many attach strong religious or spiritual significance to large water bodies such as lakes. Across Africa, people

refer to water by evocative names such as Mvura, Maji and Woha, which can all basically be translated as a thing that does something significant, causes something to be— “the fluid of creation.”

Lakes are also significant repositories of natural and human history, with ancient local political centres often arising on or near their shores. Specific lifestyles based entirely on lakes and their resources have developed in many locations, for example the ancient indigenous cultures that have sprung up around Ethiopia's Lake Tana basin.

Many Africans believe that water is a living entity, controlling the life forces of every bird, fish and other creature. As such, major freshwater lakes engender significant respect. Older cultures hold that pollution occurs in a river upstream, the water gods will become angry and dry up lakes or cause flooding. The Tonga people of Zambia believe that floods in Lake Kariba are the result of the anger of the water snake, Nyaminyami. They celebrate the lake's natural rhythm through poems, songs, dances, and other events in their daily lives. The pattern of Lake Kariba is the pattern of life in Zambia, and if that

Figure 2.3: Lakes and population dynamics



Modified from SARDC



Figure 2.4: Lake Tana, Ethiopia: Source of the Blue Nile. Lake Tana is an important cultural heritage site for the people of Ethiopia, with its islands housing some 20 monasteries—one of which is said to be the final resting-place of the Ark of the Covenant. Every year, thousands of Ethiopians and other pilgrims visit the lake, seeking divine healing from its holy waters. Credit: UNEP/GRID-Stoux Falls

pattern is damaged through the unsustainable use of its water, the whole web of life in the country will begin to unravel.

Many African cultures also have natural totems, some of which are linked to aquatic species such as fish or crocodiles. People who identify themselves with a certain

water species are not allowed to eat it or exploit it in any other way (Chenje 2000). Lakes that are regarded as holy or sacred often boast the greatest diversity of aquatic life, as exploitation of their resources is regarded as taboo or as a sin to the gods of water or lakes.

Lake water is also used for medicinal purposes by some traditional healers, who believe that drinking or bathing in it can remove human misfortunes. The ‘holy’ attributes of lake water, its use in baptisms or for exorcising evil spirits, also indirectly help in the conservation of lakes. However, due to globalisation and the gradual erosion of traditional African cultures, such beliefs are dying out – and with them traditional controls over the exploitation and pollution of these large water bodies.

Gender differences also have an impact on the utilisation of Africa’s lakes and their natural resources (Nakijoba 1996; Nanjuna 2001). Degradation of resources tends to affect men and women differently, as evidenced by the impact of the reclamation of the Nakivubo Wetlands around Lake Victoria. Declining wetland resources affect women more adversely as they tend to utilise them more than men for their households’ food and medicinal resources (Nakijoba 1996). There is a clear emerging need to mainstream gender and culture in the sustainable management and utilisation of Africa’s lake resources.

2.3 Human Health – Water for Health: Taking Charge

“Improving water management is a powerful tool that can be used by individuals, communities and households to protect their own health.”

– Dr. Gro Harlem Brundtland, Director-General of the World Health Organisation

Water-related diseases are among the most common causes of illness and death, particularly among poor communities in developing countries. Such diseases kill more than five million people each year—more than ten times the number killed in wars. They can be divided into four categories: water-borne, water-based, water-related, and water-scarce diseases. These

Victoria Falls, Zambezi River.

UNEP/stock.xchg



Table 2.1 Human well-being in Africa

Country	Total Population (thousands)	Total Fertility Rate (children per woman)	Mortality Under Age 5 (per 1000 live births)	Life expectancy at birth (years)	Health-Adjusted Life Expectancy (years)	Adults Ages 15-49 Living With HIV or AIDS (%)	Access to Improved Sanitation (% of population) 2000	
	2002	2000-2005	2000	2000-2005	2000	2001	Urban	Rural
WORLD	6211082	2.7	83	66	57	1.2	85	40
Algeria	31403	2.8	65	70.2	58.4	0.1	99	81
Angola	13936	7.2	295	45.8	36.9	5.5	70	30
Benin	6629	5.7	154	54	42.5	3.6	46	6
Botswana	1564	3.9	101	36.1	37.3	38.8	88	43
Burkina Faso	12207	6.8	198	48	34.8	6.5	39	27
Burundi	6688	6.8	190	40.6	33.4	8.3	68	90
Cameroon	15535	4.7	154	50	40.4	11.8	92	66
Central African Rep	3844	4.9	180	44.3	34.1	12.9	38	16
Chad	8390	6.6	198	46.2	39.3	3.6	81	13
Congo	3206	6.3	108	51.6	42.6	7.2	14	..
Congo, Dem Rep	54275	6.7	207	52.1	34.4	4.9	54	6
Côte d'Ivoire	16691	4.6	173	47.9	39	9.7	71	35
Egypt	70278	2.9	43	68.3	57.1	<0.1	100	96
Equatorial Guinea	483	5.9	156	52	44.8	3.4	60	46
Eritrea	3993	5.3	114	52.4	41	2.8	66	1
Ethiopia	66040	6.8	174	43.3	35.4	6.4	33	7
Gabon	1293	5.4	90	52.9	46.6	..	55	43
Gambia	1371	4.8	128	47.1	46.9	1.6	41	35
Ghana	20176	4.2	102	57.2	46.7	3	74	70
Guinea	8381	5.8	175	48.5	40.3	..	94	41
Guinea-Bissau	1257	6	215	45.4	36.6	2.8	95	44
Kenya	31904	4.2	120	49.3	40.7	15	96	82
Lesotho	2076	4.4	133	40.2	35.3	31	72	40
Liberia	3298	6.8	235	55.6	37.8
Madagascar	16913	5.7	139	53.6	42.9	0.3	70	30
Malawi	11828	6.3	188	39.3	30.9	15	96	70
Mali	12019	7	233	52.1	34.4	1.7	93	58
Mauritania	2830	6	183	52.5	41.4	..	44	19
Morocco	30988	3	46	68.6	54.9	0.1	86	44
Mozambique	18986	5.9	200	38	31.3	13	68	26
Namibia	1819	4.9	69	44.3	35.6	22.5	96	17
Niger	11641	8	270	46.2	33.1	..	79	5
Nigeria	120047	5.4	184	52.1	41.6	5.8	66	45
Rwanda	8148	5.8	187	40.9	31.9	8.9	12	8
Senegal	9908	5.1	139	54.3	44.8	0.5	94	48
Sierra Leone	4814	6.5	316	40.5	29.5	7	88	53
Somalia	9557	7.2	225	48.9	35.1	1
South Africa	44202	2.8	70	47.4	43.2	20.1	93	80
Sudan	32559	4.5	108	57	45	2.6	87	48
Tanzania, United Rep	36820	5	165	51.1	38.1	7.8	99	86
Togo	4779	5.4	142	52.2	42.7	6	69	17
Tunisia	9670	2.1	28	70.9	61.4	..	96	62
Uganda	24780	7.1	127	46	35.7	5	93	77
Zambia	10872	5.7	202	42.2	33	21.5	99	64
Zimbabwe	13076	4.5	117	42.8	38.8	33.7	71	57

Source: WRI 2004

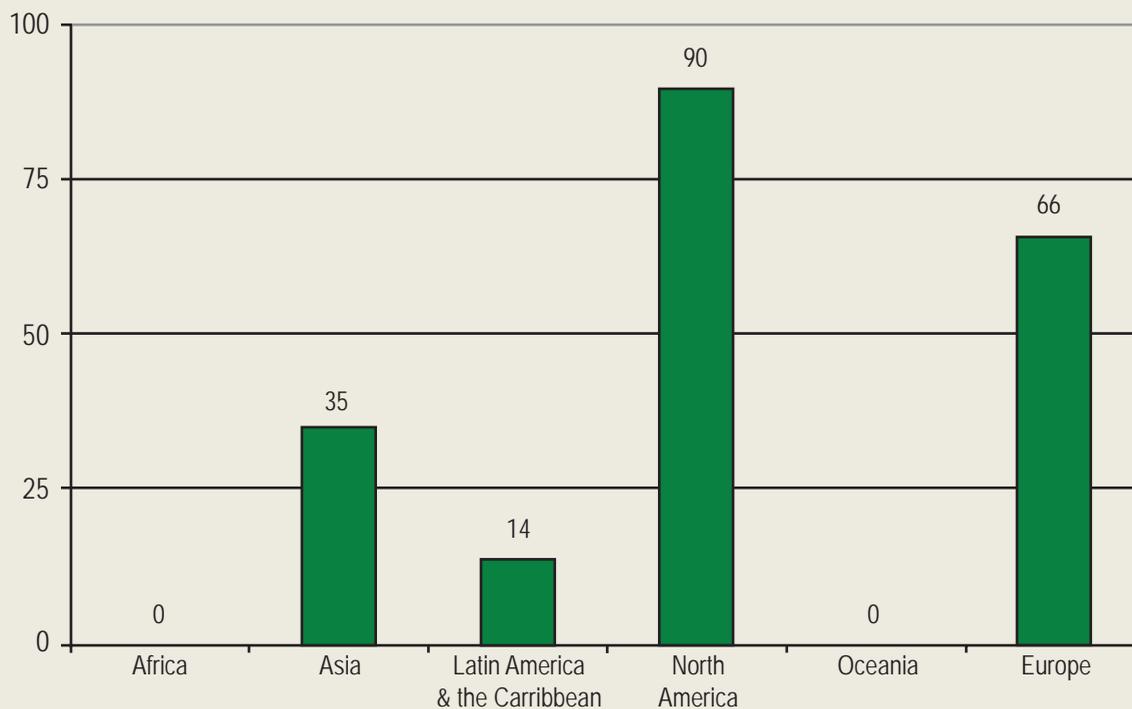


Figure 2.5: Median per cent of wastewater treated by effective treatment plants

Source: WHO 2001

diseases are very common among communities living close to lakes in Africa.

The most common water-borne diseases—cholera, dysentery, typhoid and hepatitis—are among the greatest emerging and re-emerging infectious diseases, contributing up to 70-80 per cent of all health problems in developing countries. Their causative agents may be bacterial or viral in nature and generally have endemic and epidemic periods. The burden of these diseases is felt in almost every African country—particularly those with large water bodies like lakes.

More than half of Africa's people lack access to safe drinking water, leaving them vulnerable to water-borne diseases. Whatever the quality, water is often in short supply. In rural Africa, people use four to nine gallons of water a day per person for domestic purposes, and much of this is untreated water drawn directly from rivers or lakes.

Food production also suffers from major water shortages. Of all the renewable water available in Africa each year, only four per cent is actually used, because most Africans lack the wells, canals, pumps, reservoirs and other irrigation systems needed to make use of potential water supplies from their lakes.

Point and non-point source pollution of surface and ground water also poses a major threat to public health, coming not only from human waste but also from agricultural runoff, waste dumps, mining and industry. For example:

- High concentrations of nitrates from agriculture in drinking water result in oxygen-starvation in the brain. This is especially dangerous for babies;
- Benzene, a component of petrol, is carcinogenic (cancer-causing);

- Most heavy metals are toxic. For example, arsenic is carcinogenic, lead damages the nervous system, cadmium results in kidney problems, and chromium can cause severe skin reactions;
- Most organic components of products like pesticides, tar and solvents are toxic; they can lead to kidney and liver problems, heart problems, damage to the nervous system, cancer, and skin problems.

Ensuring access to safe fresh water is imperative. Water is an economic issue as it is essential for agriculture, food and energy production, as well as for recreation. In the developing world, it is a women's issue as women have the primary responsibil-

ity for domestic water collection. Time spent gathering water robs women and girls of time for education or for engaging in meaningful work. It is also, of course, a children's issue as water is essential for healthy development. It is estimated that a child dies every eight seconds from water-borne diseases.

It is clear that the proper management of waste disposal into lakes is critical in order to ensure the health and wellbeing of African communities. The use of dichlorodiphenyltrichloroethane (DDT) to control malaria around many lakes can also threaten people's health due to its environmental persistence and ability to bioaccumulate, especially in higher animals. Significant amounts of DDT have been discovered in fish in Lake Kariba, which are believed to be the major cause of the death of fish-eating birds. Of particular concern is DDT's potential to mimic hormones and thereby disrupt endocrine systems in wildlife and people.

Some lakes in Africa contain large amounts of carbon dioxide (CO_2), which when released can be fatal to people and animals. Lake Nyos is one of Africa's best-known "killer lakes." On 21 August 1986, the lake released a large cloud of CO_2 , which flowed down neighbouring valleys, travelling as far as 26 kilometres (16 miles) from the lakeshore. The cloud reportedly moved fast enough to flatten much of the vegetation in its path, including several trees. A total of 1 746 people suffocated, while an additional 845 people had to be hospitalised.

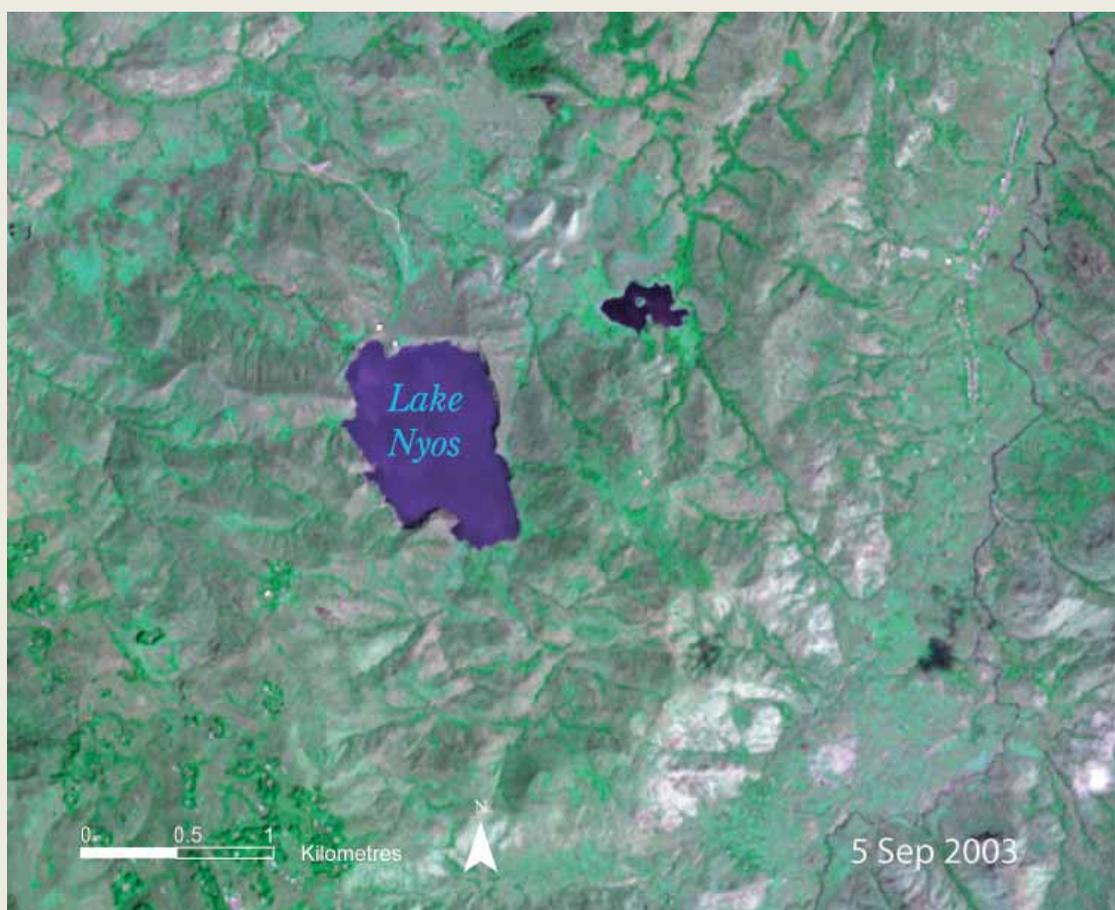


Figure 2.6: Lake Nyos in Cameroon. In August 1986, a cloud of carbon dioxide gas from the lake killed more than 1 700 people and several animals within a 25 km (16 mile) radius (USGS 1986). Credit: Jack Lockwood

2.4 Recreation and Tourism

Nature-based tourism is one of Africa's fastest-growing industries, with a growth rate of nearly seven per cent in international visitor arrivals between 2004 and 2005. As well as national parks and wildlife reserves, lakes provide some of the continent's most important flora and fauna areas and recreation destinations. Some lakes, such as Lake Malawi and the St. Lucia wetlands, are also protected as World Heritage Sites under the World Heritage Convention of 1975 (Chenje 2000). Visitors come to these lakes to enjoy boating and watersports, as well as to witness the remarkable range of freshwater and inland biodiversity that they support.

Ecotourism has also increased environmental conservation as people struggle to maintain Africa's lakes in their natural state as a way to sustain local tourism activities. Many riparian states have gazetted conservation areas and enacted strict laws to protect wildlife and plant life around their lakes. Elephants, which were about to face extinction, have increased around Lake Tanganyika and Lake Kariba as tourists seek them out. The establishment of game parks around lakes is a strategy that allows tourists to see many different kinds of animals in one location (IUCN 2004). African lakes also house about 500 different aquatic species, creating the potential for sustainable fishing activities.

Despite all these opportunities, however, increasing tourism can also have negative impacts. Without proper management and regulation, growing tourist facilities, roads and other infrastructure can wreak havoc on fragile freshwater environments. A rapid increase in visitor numbers can render lakeside developments environmentally unsound—and negatively impact the very creatures that brought people

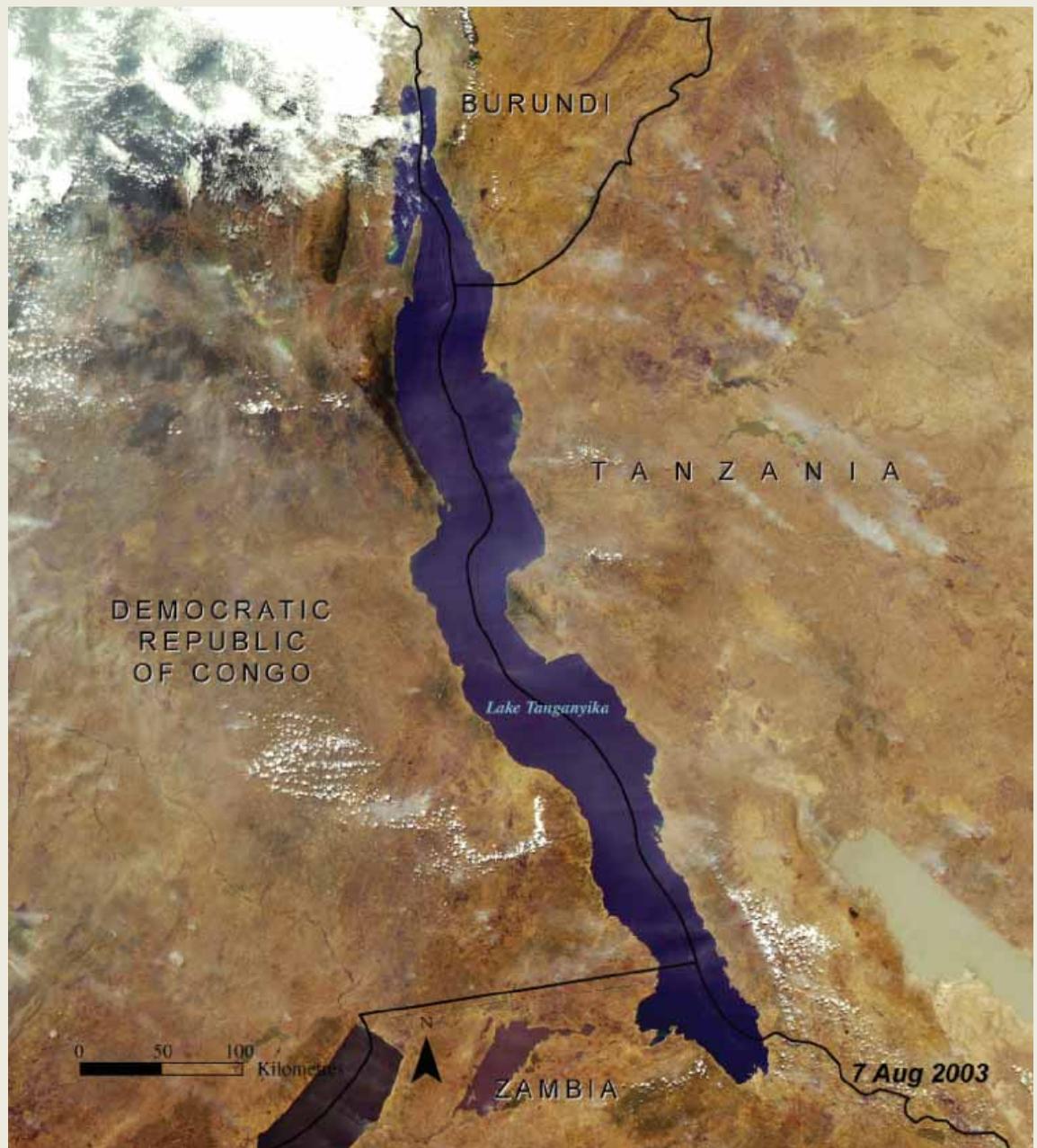


Figure 2.7: According to scientists, climate change in East Africa is harming Lake Tanganyika's ecosystem, decreasing fish stocks by as much as 30 percent over the past 80 years. Lake Tanganyika is large and deep, filling the chasm of a rift valley bordering the Democratic Republic of Congo, Tanzania, Zambia and Burundi. An ecosystem unto itself, the lake supports many types of fish. Only a few species are eaten by people, yet they supply 25 to 40 per cent of the animal protein for the communities of that region. Recently, the fish supplies have diminished, and catches are shrinking (NASA 2003). *Credit: UNEP/GRID-Sioux Falls*

there in the first place. Areas within easy reach of large population centres are particularly under threat.

Even apparently harmless activities such as boating and rafting can pose a threat to fragile lake environments. The growing number of boats on Lake Kariba,

Lake Tanganyika

Science Museum of Minnesota/UNEP/Wildchimpanzees.org



Table 2.2: Examples of the link between MDGs and environment in Africa's Lakes

Eradicate extreme poverty and hunger	Livelihood strategies and food security of people often depend directly on healthy ecosystems and the diversity of goods and ecological services they provide.
Achieve universal primary education	Time spent collecting water and fuelwood by children, especially girls, can reduce time at school.
Promote gender equality empower women	Women are especially exposed to indoor air pollution, have the burden of collecting water and fuelwood, and have unequal access to land and other natural resources.
Reduce child mortality	Water-related diseases such as diarrhea and cholera kill an estimated three million people a year in developing countries, the majority of which are children under the age of five.
Improve maternal health	Indoor air pollution and carrying heavy loads of water and fuelwood adversely affect women's health and can make women less fit for childbirth and at greater risk of complications during pregnancy.
Combat major diseases	A large proportion of total burden of diseases in Africa's Lakes may be associated with environmental risk factors. Preventive environmental health measures are as important and at times more cost-effective than health treatment.
Ensure environmental sustainability	Current trends in environmental degradation in Africa's lake basins must be reversed in order to sustain the health and productivity of the basins' ecosystems.
Develop a global partnership for development	Too many developing countries are spending more on debt service than on social services. The aim is to build coalitions for action and help governments set priorities and use resources, including water resources, more effectively.

Source: IUCN 2004

for example, is increasing oil and fuel pollution of the lake waters – both from accidental leakages and the deliberate dumping of waste oil into the lake. Oil reduces the water quality, and can be fatal to many aquatic animal and plant species.

Likewise, noise pollution and the wave action of motorboats can harm riverbanks and, over time, cause irreparable damage to their micro-ecology. There is mounting concern about the impact of sport angling on certain game-fish species, as well as the effects of introducing alien species such as trout and bass, which are favoured by anglers.

At Lake Kariba, concerns are growing over the impact of sewage discharges from local lodges and settlements, siltation from erosion caused by riverbank disturbance, overexploitation of wetland resources such as reeds and fish, and pollution by fuels and pesticides. All of these factors pose a significant threat to the flora and fauna upon which the lake's tourism industry is based.

The souvenir or curio industry has developed as a byproduct of tourism and is a big consumer of indigenous hardwoods. The over-harvesting of large and increasingly rare indigenous trees is occurring—unsustainably, and often illegally—in many parts of Africa where tourism is thriving. The World Wide Fund for Nature recently estimated that nearly 250 m³ (327 cubic yards) of wood is carved per year (WWF 2005).

2.5 Fishing

Fishing is vital to Africa, supporting annual exports worth about US\$3 000 million. Fish are crucial to the health of 200 million Africans, providing a source of inexpensive protein, and income for over 10 million people engaged in fish production, processing and trade. The fishing sector also plays an important role in the alleviation of poverty and general food security in Africa. In Malawi, the FAO states that 70 per cent of dietary animal protein is derived from fish, and the fishing sector constitutes a

major source of income and livelihood for more than 300 000 people.

Lakes in Africa support 16-17 per cent of inland fisheries (Sithole 2000). Across much of the continent, lake fisheries provide an important source of food and livelihood for millions of people. Yet these benefits are at risk as the exploitation of natural fish stocks is reaching its limit and aquaculture production has not yet fulfilled its potential (FAO 2004).

Table 2.2 shows the link between Millennium Development Goals and fisheries in Africa. It is important to note that the sound management of Africa's fisheries is vital if these Millennium Development Goals are to be attained. This includes the integrated management of all major freshwater bodies, including lakes.

African lakes are among the largest and most ecologically diverse on Earth—but are also among its most endangered water systems. Population densities are higher along the shores of Lakes Tanganyika,

Box 2.1: Economic Value of Some Lake Fisheries

- More than 60 per cent of the fish consumed in Tanzania comes from inland fisheries, and about 60 per cent of the protein intake in Malawi comes from freshwater fish.
- The creation of Lake Kariba produced a viable regional fishery in an area in which freshwater fish were previously absent from the diet of Zimbabweans.
- Lake Victoria generates an annual GDP of US\$3 000–4 000 million, providing more than 25 000 people with an annual income of US\$90-270 per capita.
- The eutrophication of Lake Chivero threatens the health and livelihoods of nearly three million inhabitants in the greater Harare/Norton urban areas, and has caused the virtual collapse of a once-thriving fishing industry.

Source: ILEC 2003



Harvesting fish in a pond after periodical drainage.

R. Cannarsa/UNEP/FAO

Table 2.3: Summary results of agricultural water use and comparison with water resources

Region	Total renewable water resources (km ³)	Irrigation water requirements (km ³)	Water requirement ratio	Water withdrawal for agriculture (km ³)	Water withdrawal as percentage of renewable water resources
Latin America	13 409	45	24%	187	1%
Near East and North Africa	541	109	40%	274	51%
Sub-Saharan Africa	3 518	31	32%	97	3%
East Asia	8 609	232	34%	693	8%
South Asia	2 469	397	44%	895	36%
90 developing countries	28 545	814	38%	2 146	8%

Source: FAO 2005, AGL 2005

Victoria and Malawi. With four of Africa's Great Lakes on its borders, Uganda ranks as one of the world's largest producers of freshwater fish. But pollution, the introduction of non-native fish, and over-fishing have all taken a heavy toll on these waters.

Africa's fishing sector urgently needs strategic investments to safeguard its future contribution to poverty alleviation and regional economic development. Broadly, Africa needs investments to (i) improve the management of natural fish stocks, (ii) develop aquaculture production, and (iii) enhance fish trade in domestic, regional and global markets. In support of this investment, capacity needs to be strengthened at both the regional and national levels for

research, technology transfer and policy development. As a first step, stakeholders in the region need to build a common and strategic understanding of the importance of fisheries and aquaculture for Africa's development and of the challenges being faced by the sector.

The New Partnership for Africa's Development (NEPAD) is taking the lead in developing regional priorities for future investments in fisheries and aquaculture as part of its wider agriculture programme. Following an invitation from President Olusegun Obasanjo of Nigeria, the World-Fish Center and the FAO are supporting NEPAD in developing an integrated approach for the sustainable management of

fisheries in Africa's lakes. This is critical, as poor fishing habits are still known to be poisoning large water bodies in most African countries.

2.6 Water Withdrawal and Irrigation

On the African continent as a whole, 85 per cent of water withdrawals are used for agriculture—and the percentage is even higher in sub-Saharan Africa (Table 2.3). Sub-Saharan Africa lags far behind the rest of the world in the proportion of irrigated arable land to its contribution to the total food supply. In North Africa, 11 per cent of the land is irrigated (excluding Egypt's 100

Sunrise, Lake Baringo, Kenya

Aftab Uzzaman/UNEP/Flickr.com



per cent), whereas in sub-Saharan Africa, it is only 3.5 per cent of total cropped land (FAO 1986a, b, c). In North Africa, 3.4 million ha are irrigated by large-scale systems, whereas in sub-Saharan Africa, half of the 5.3 million ha is irrigated by large- and medium-scale systems; the other half is by small-scale systems. In terms of value, irrigation is responsible for an estimated 33 and nine per cent of the crops produced in North Africa and sub-Saharan Africa respectively (Yudelman 1994). In those areas, the water withdrawn for agriculture from the hydrologic system may represent a significant part of the total water resources.

The ways in which freshwater resources are used for agriculture leave much to be desired. In some places, water use exceeds renewable supply rates and cannot be indefinitely continued. Elsewhere, overuse in one area deprives users in other areas, leading to agricultural production decreases and the loss of jobs. Misuse occurs where water is returned to the water system in an unusable state. Used irrigation water is often contaminated with salts, pesticides and herbicides.

Irrigation from lakes can also jeopardise aquatic ecosystems such as wetlands, leading to losses in their productivity and biodiversity. This has important implica-

tions for people who depend upon the major inland fisheries that such areas support. Wetlands serve as natural filters that have historically been responsible for cleaning up much of the world's wastewater. Where they have been eliminated in the name of irrigation, the results are usually regretted.

A positive impact is that highly productive irrigation of a small area can often replace the use of a much larger area of marginal land for growing crops. Improving the environmental performance of irrigation projects is important for their long-term sustainability.

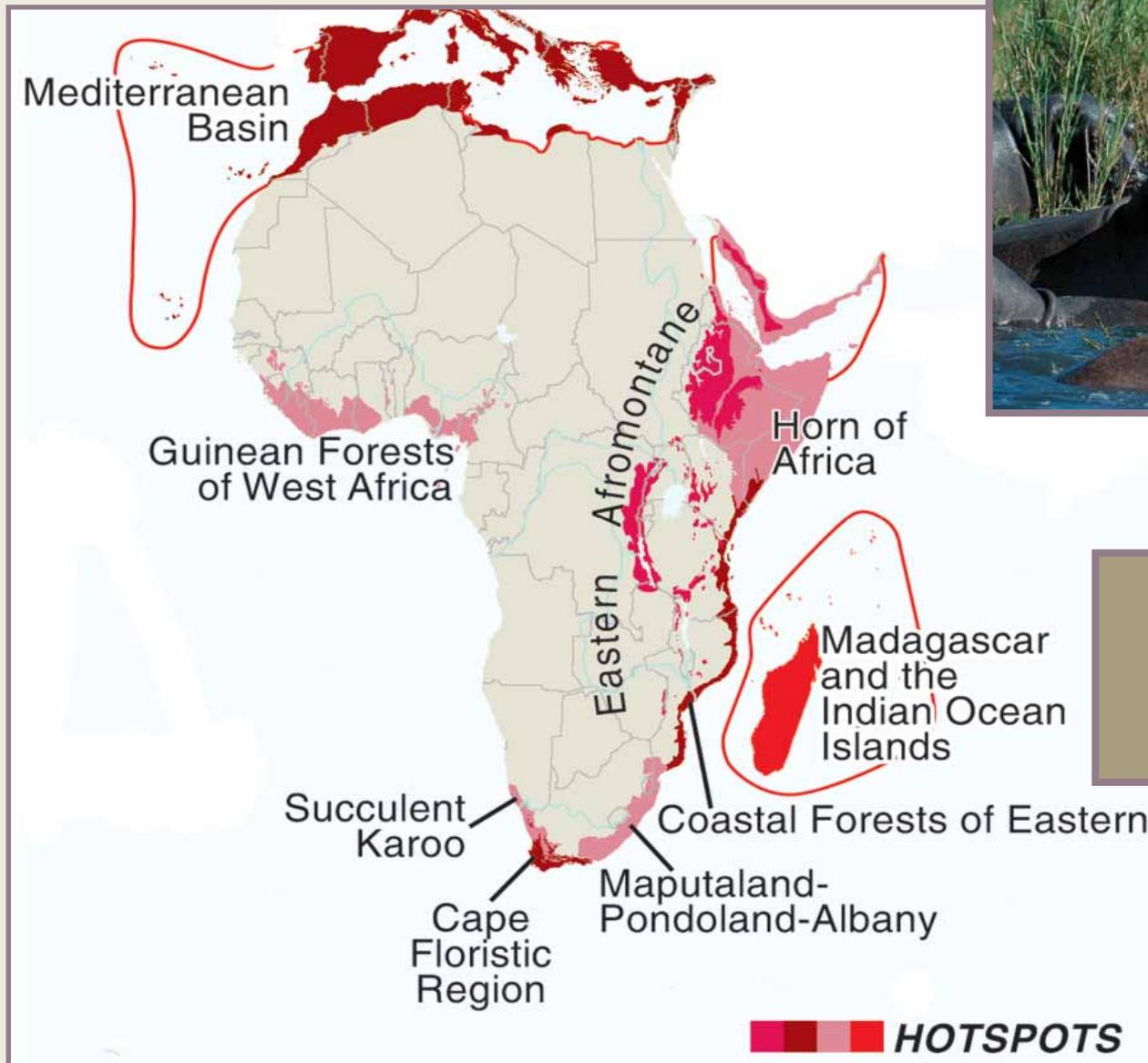
2.7 Aquatic Biodiversity and Habitats

Lakes provide critical habitat for an amazing array of plants and animals, including bacteria, fungi, algae, plankton, mussels,

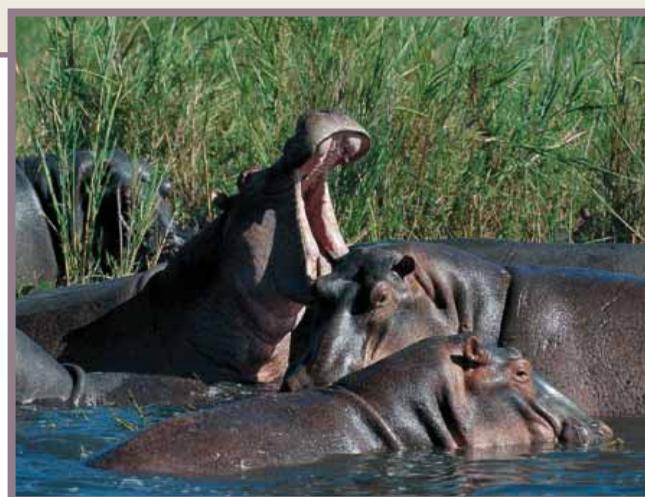
Figure 2.9: A satellite image of Lake Malawi, which occupies one-fifth of its country's total area. The lake drains an area larger than Malawi itself, yet surprisingly, only one river—the Shire—flows from it. The lake has one of the highest diversities of freshwater tropical fish in the world, some of which are only found here. Fishing for salmon, bream, bass and tigerfish are popular here, as are snorkelling and diving. The 587 km (365 mile) long, 84 km (52 mile) wide lake—often called the “calendar lake”—is the third largest in Africa, and the ninth largest in the world. *Credit: UNEP/GRID-Sioux Falls*



Figure 2.8: Biodiversity hotspots of Africa



Source: Conservation International 2005



Biodiversity in Lake Malawi
Unknown/UNEP/Tourismmalawi



Golden crowned cranes (*Balearica regulorum*), Uganda.
William M. Ciesla/UNEP/Forest Health Management International, www.forestryimages.org.

Box 2.2: Alien Invasion: the Nile Perch of Lake Victoria

Nile Perch (*Lates niloticus*) were introduced into Lake Victoria in the mid-1950s, with the goal of boosting local fisheries production. With a voracious appetite for other fish, the perch decimated the lake's 350 native fish species, reducing the number to less than 50 according to some estimates. In short order, it worked its way to the top of the lake's food chain.

The Nile perch can grow to enormous sizes. Typical commercial specimens range from 3-6 kg (7-13 lbs), but the fish can grow to 1.8 m (6 ft) and weigh over 90 kg (200 lbs). Because of the fish's large size, the nature of indigenous fisheries has also changed. While the native lake fish were much smaller and ideal for sun drying, the larger perch require factory processing.

A large Nile perch caught in Lake Victoria. The fish is often dried, salted and exported to neighbouring countries or overseas.



Josh Goldstein/UNEP/Flickr.com

snails, crustaceans, insects, fish, amphibians, reptiles, birds and mammals. Despite their importance, however, lakes continue to be fairly invisible on the global conservation screen. Lakes and their watersheds are dramatically underrepresented both in protected areas and in the significance of the aquatic biodiversity they hold. Many African lakes boast some of the world's richest freshwater ecosystems, harbouring a broad diversity of endemic species that exist nowhere else on Earth. They are often surrounded by wetlands that store significant volumes of fresh water, as well as

serving as vital habitats for endemic wildlife and transit-points for migratory species.

Lake Victoria is home to more than 300 endemic species, Lake Tanganyika 140, and Lake Malawi nearly 500. Lake Malawi provides over 60 per cent of the animal protein consumed by the country's entire population. Such figures demonstrate the major 'natural capital' generated by Africa's lakes – the broad range of social, economic, ecological and hydrological functions on which people, especially the poor, often directly depend. Understanding the full range of benefits and services provided

by these aquatic ecosystems is critical to the conservation of the continent's lakes.

As biodiversity 'hotspots' – regions of the Earth with vitally important but critically endangered biodiversity – Africa's lakes and wetlands share high concentrations of unique plant and animal species and high degrees of threat. Although they are clearly of great regional importance to livelihoods and economies, development activities are not always compatible with the conservation of their biodiversity. One of the main reasons for the inadequate representation of biodiversity in development planning processes is a widespread lack of readily available information on the status and distribution of inland water taxa.

Pollution and sedimentation, as well as the introduction of invasive species, pose the greatest threat to the aquatic biodiversity of Africa's lakes. On a basic level, activities that influence aquatic environments and biological systems, like forest clearing, the burning of fossil fuels, agricultural pollution and soil loss, lead to greater emissions of carbon dioxide and an increase in global warming. The impacts of climate change are projected to accelerate aquatic plant and animal population losses and the extinction of a wide range of species and ecosystems. Some of those lakes richest in aquatic biodiversity are already being affected, most notably Lake Victoria and the Okavango Delta. It is estimated that at least 30 per cent of freshwater fish and over 800 other freshwater species are on the brink of extinction in Africa's lakes (IUCN 2002).

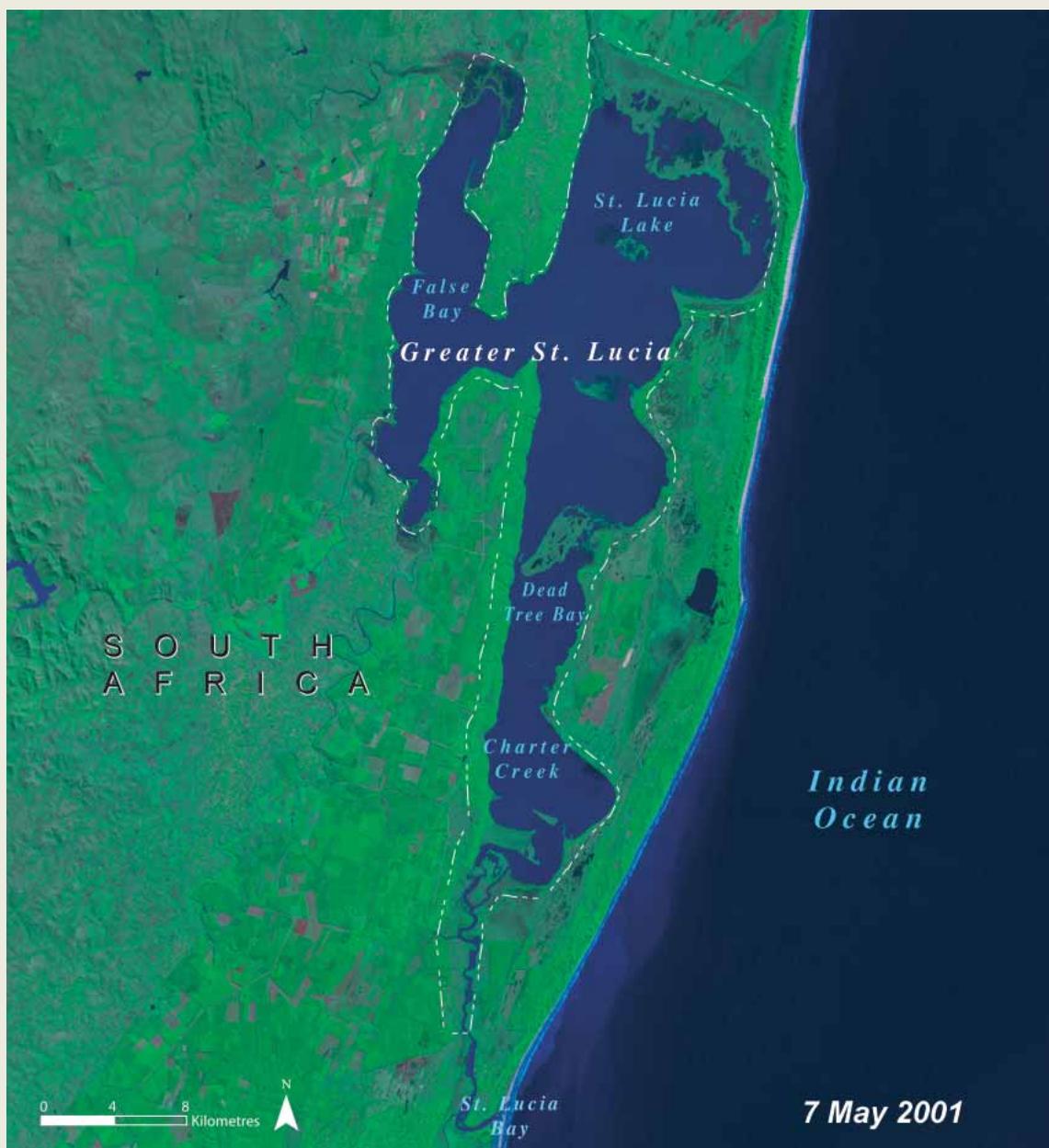


Figure 2.10: A satellite image of Lake St. Lucia. St. Lucia Lake is part of the St. Lucia estuarine system, the largest estuarine system in Africa. Like other estuaries, the level and salinity of the lower reaches of St. Lucia especially varies with the inflow of freshwater from several rivers and with the ebb and flow of marine tides. It is also the most biodiversity rich lake in Southern Africa. In some years, the water's salinity has risen to three times the level of sea water in northern parts of the lake, causing mass die-offs of aquatic plants and animals. Credit: UNEP/GRID-Sioux Falls

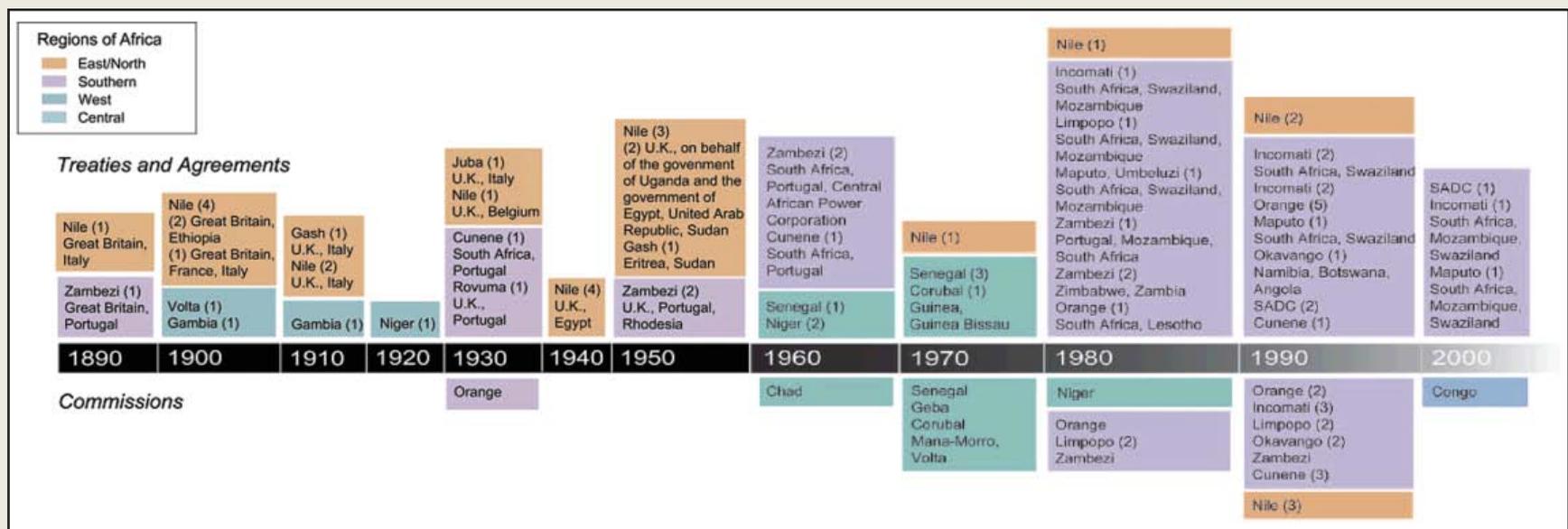


Figure 2.11: Timeline of transboundary agreements and river basin organizations in Africa, 1890–2000

Source: UNEP 2005

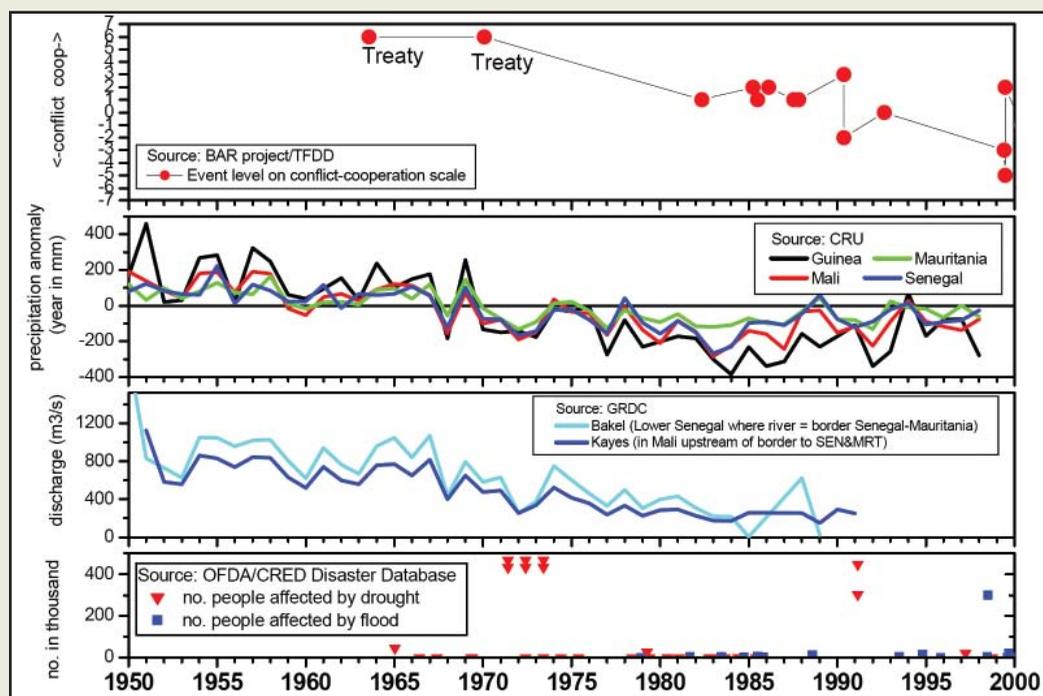


Figure 2.12: Time-series of events of conflict and cooperation, precipitation anomaly, annual mean discharge and the occurrence of natural disasters in the Senegal River Basin. Note: BAR – Basin at Risk; TFDD – Transboundary Freshwater Dispute Database; CRU – the Climate Research Unit; GRDC – Global Runoff Data Center; OFDA – Office of U.S. Foreign Disaster Assistance; CRED – Center for Research on the Epidemiology of Disasters.

Source: Wolf *et al.* 2003

2.8 Transboundary Lakes and Water Resources Issues

Africa has some 80-transboundary river and lake basins, and the catchments areas of the 17 largest exceed 100 000 square kilometers (24 710 538 acre) each (UNU n.d.). There are 15 principal lakes and 24 principal watersheds that cross the political boundaries of two or more countries in Africa (Figures 2.14 and 2.15). Almost all the landmass falls within transboundary river and lake basins in 14 African countries (UNU n.d.). These international basins cover 45.3 per cent of the continent's land surface, affect about 40 per cent of its population, and account for approximately 60 per cent of global river flows (Wolf *et al.* 1999).

The main challenge in water resources management is to create an enabling environment that encourages joint management of transboundary water resources. Agenda 21, the plan of action adopted at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, recognized the great significance of transboundary water resources and their use by riparian states, and called for cooperation among those states for integrated approaches to the development, management and use of their transboundary freshwater resources. Water is

Box 2.3: Impacts of Lake Sedimentation in Lake Baringo (Kenya)

Until the mid-1970s, Lake Baringo was very rich in biodiversity. Growing human and livestock populations, drainage basin destruction, indiscriminate cutting of forests and charcoal burning, and poaching have since reduced this richness. For example, although there were seven rivers continuously flowing into the lake in the mid-1970s, only one river now flows into the lake during all seasons. It is estimated that five million cubic metres (6.5 million cubic yards) of sediment are currently being deposited into the lake each year from the drainage basin. The combination of reduced inflows and increased sediment

loads has reduced the depth of the lake from about 8.9 metres (29 ft) in the mid-1970s to about 1.9 metres (6 ft) today. It is estimated that if the lake continues to accumulate sediment at the present rate, it will change dramatically in character within the next 20 years, possibly drying up altogether or becoming a swamp. The impacts of sedimentation are best illustrated by its effects on fish biodiversity, with species that contributed to local livelihoods (e.g., Sharks [*Labeo spp.*]) becoming almost extinct. Depleted fish stocks also have had impacts on other biodiversity, including fish-eating birds, many species of which have been significantly reduced since 1980. (Source: ILEC 2003)

identified as a central issue in the Millennium Development Goals, a set of time-bound and measurable goals and targets for combating various environmental and development problems adopted by heads of state gathered at the UN Millennium Summit in September 2000. Water resource management was also high on the agenda at the World Summit on Sustainable Development (WSSD) held in Johannesburg in September 2002 (Rio +10). The importance of management of transboundary water systems has also been explicitly and concretely recognized by the international community, as signified by the establishment of the Convention on the Law of the Non-navigational Uses of International Watercourses adopted by the UN General Assembly in 1978 after nearly three decades of drafting (Ruphael 2004).

Figure 2.13: A satellite image of Lake Kariba, found in the Zambezi River between the Zambia-Zimbabwe borders. Although at present water supply exceeds demand by far, this situation might change in the future due to the possible development of water use by the upstream-riparian Angola as civil war ends. In addition to ambitious new projects, possible further Inter-Basin Transfers threaten future water conflicts in the basin. Pollution of Lake Kariba by the two countries, Zambia and Zimbabwe, is also seen as future source of conflict. However, there is need for equity and sustainable utilization of the lakes resource to avoid conflict among the two countries.

Credit: UNEP/GRID-Sioux Falls



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